District Heating Water Quality

Ordinary General Meeting 2019

Scandinavian IAPWS Commettee, 19. marts 2019

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Success criterias for water treatment

- Optimum and economical operation both in short- & long term.
- Low consumption of chemicals.
- Minimum environmental impact – internal as well as externally.
- Reduction of risks for corrosion of pipes and other key assets.

Source: Danish District Heating Association, latest recommendations:

”Water Treatment & Prevention of Corrosion”.

Download from: www.eurowater.com

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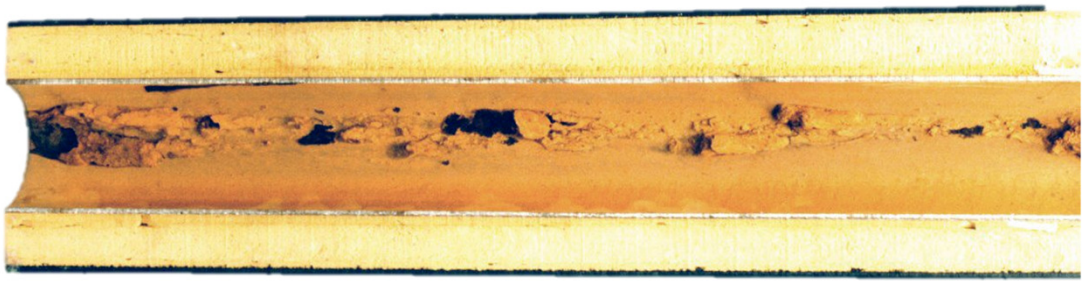
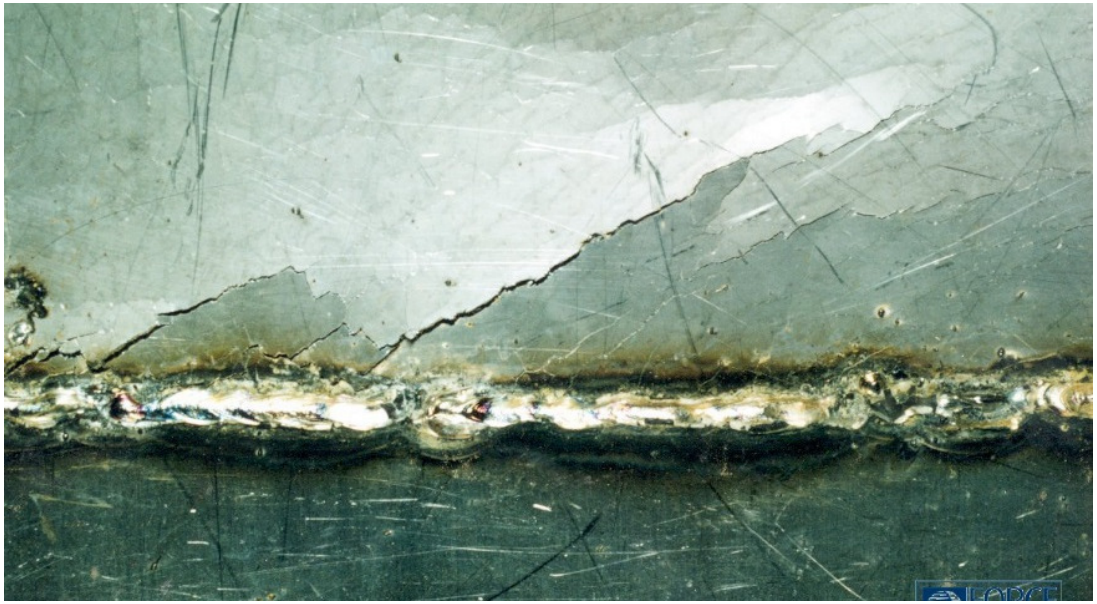
Take care of the new District Heating Pipes





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Succes criteria for water treatment

Avoid corrosion

- Pitting
- Microbial corrosion
- Coating corrosion / Coveringcorrosion
- Tension corrosion

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Succes criteria for water treatment

Avoid formation of deposits

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Succes criteria for water treatment

Avoid bio corrosion

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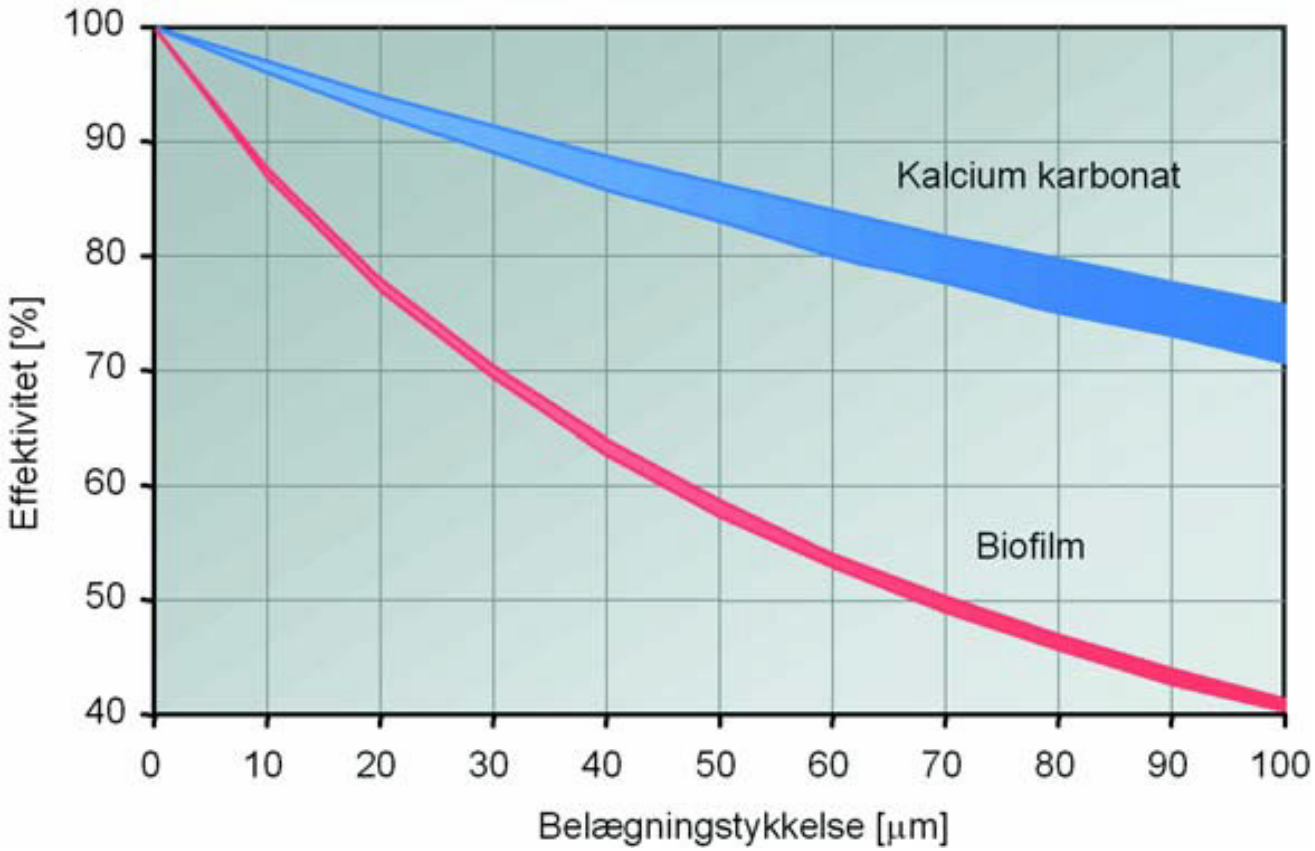
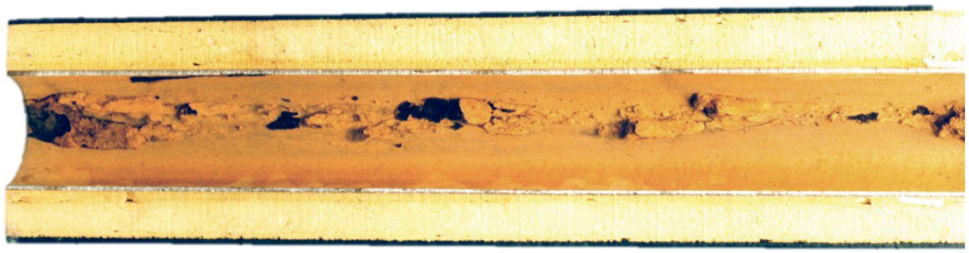
Effectivity in - heattransmission

Heattransmission substantially worse in biofilms than in limescale.





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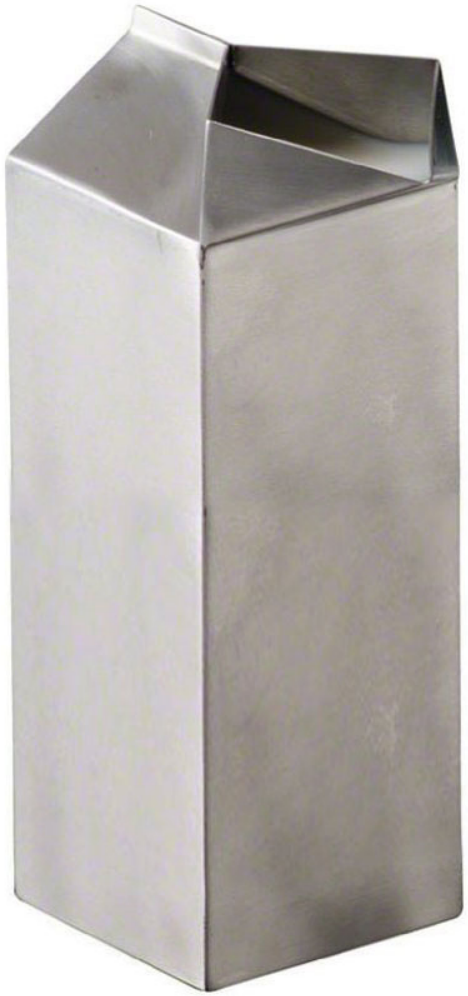
Oxygen corrosion of steel

1 m^3 drinking water typically contains 5-6 g of oxygen and oxidizes 10-15 g iron in corrosion. This is equal to 2 pcs. 1 EURO coins.



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Oxygen corrosion of steel

If 500 m^3 drinking water passes through a district heating system without degassing up to 7,5 kg of material can disappear due to corrosion. That is equal to a iron block the size of a milk carton!

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Factors promoting corrosion

- Aggressive ion content
- Oxygen content
- pH value in the water
- Biological activity

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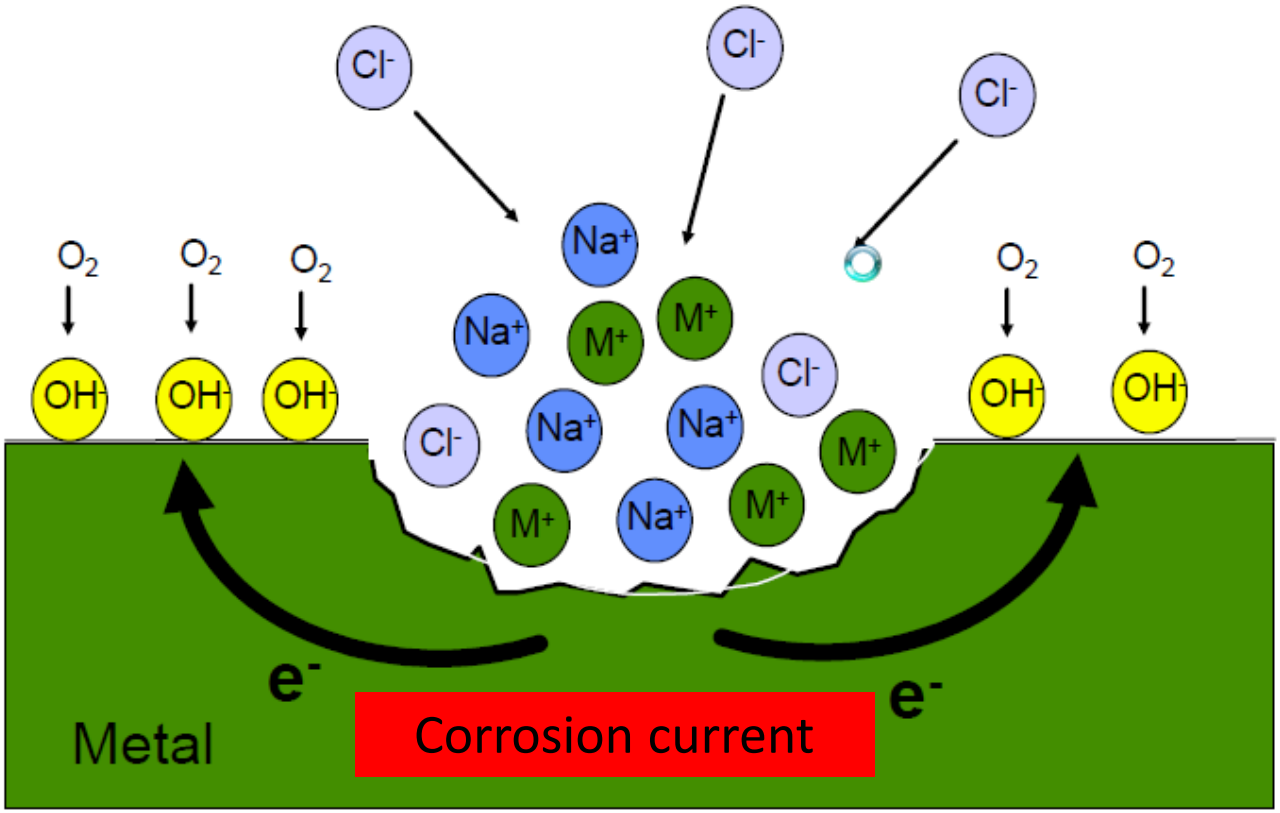

Pitting

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Water Quality

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New recommendations from Danish District Heating Association

The purpose of water treatment is:

- Secure operation
- Maintenance of the huge investments in district heating systems.
- Water treatment is to make preventive maintenance in account to the specific system – both new and old.
- Increased costs for production of water often makes a profit in the long run.

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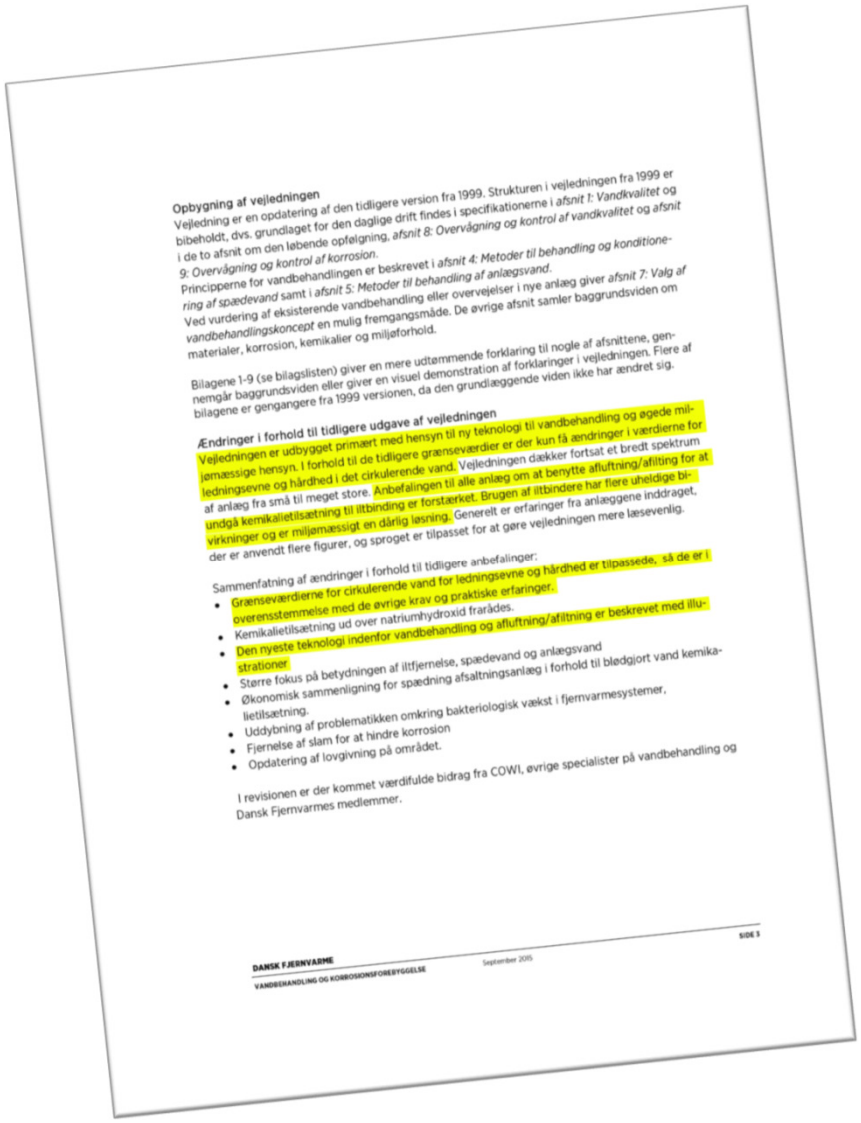
New recommendations from Danish District Heating Association

Changes from previous recommendation – 1999 :

- New technologies for water treatment and increased environmental issues
- Changes in values for conductivity and hardness of the circulating water.
- Strenghtening of recommendations for all plants to make use of dearators in order to avoid chemicals. Use of Oxygen scavenging chemical have several unfortunate side effects and is a bad solution for the environment.
- More focus on removal of oxygen, specifications of make-up water etc.



Opbygning af vejledningen
Vejledning er en opdatering af den tidligere version fra 1999. Strukturen i vejledningen fra 1999 er bibeholdt, dvs. grundlaget for den daglige drift findes i specifikationerne i *afsnit 1: Vandkvalitet* og i de to afsnit om den løbende opfølgning, *afsnit 8: Overvågning og kontrol af vandkvalitet* og *afsnit 9: Overvågning og kontrol af korrosion*.
Principperne for vandbehandlingen er beskrevet i *afsnit 4: Metoder til behandling og konditionering af spædevand* samt i *afsnit 5: Metoder til behandling af anlægsvand*.
Ved vurdering af eksisterende vandbehandling eller overvejelser i nye anlæg giver *afsnit 7: Valg af vandbehandlingskoncept* en mulig fremgangsmåde. De øvrige afsnit samler baggrundsviden om materialer, korrosion, kemikalier og miljøforhold.

Bilagene 1-9 (se bilagslisten) giver en mere udtømmende forklaring til nogle af afsnittene, gennemgår baggrundsviden eller giver en visuel demonstration af forklaringer i vejledningen. Flere af bilagene er gengangere fra 1999 versionen, da den grundlæggende viden ikke har ændret sig.

Ændringer i forhold til tidligere udgave af vejledningen
Vejledningen er udbygget primært med hensyn til ny teknologi til vandbehandling og øgede miljømæssige hensyn. I forhold til de tidligere grænseværdier er der kun få ændringer i værdierne for ledningsevne og hårdhed i det cirkulerende vand. Vejledningen dækker fortsat et bredt spektrum af anlæg fra små til meget store. Anbefalingen til alle anlæg om at benytte afluftning/afilting for at undgå kemikalietilsætning til iltbinding er forstærket. Brugen af iltbindere har flere uheldige bivirkninger og er miljømæssigt en dårlig løsning. Generelt er erfaringer fra anlæggene inddraget, der er anvendt flere figurer, og sproget er tilpasset for at gøre vejledningen mere læsevenlig.

Sammenfatning af ændringer i forhold til tidligere anbefalinger:
- Grænseværdierne for cirkulerende vand for ledningsevne og hårdhed er tilpassede, så de er i overensstemmelse med de øvrige krav og praktiske erfaringer.
- Kemikalietilsætning ud over natriumhydroxid frarådes.
- Den nyeste teknologi indenfor vandbehandling og afluftning/afiltning er beskrevet med illustrationer
- Større fokus på betydningen af iltfjernelse, spædevand og anlægsvand
- Økonomisk sammenligning for spædning afsaltningsanlæg i forhold til blødgjort vand kemikalietilsætning.
- Uddybning af problematikken omkring bakteriologisk vækst i fjernvarmesystemer,
- Fjernelse af slam for at hindre korrosion
- Opdatering af lovgivning på området.

I revisionen er der kommet værdifulde bidrag fra COWI, øvrige specialister på vandbehandling og Dansk Fjernvarmes medlemmer.

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New recommendations from Danish District Heating Association

Summary of changes regarding former recommandations:

- The limits for circulating water for conductivity and hardness is adjusted, so they corrospond to the other specificatoins and practical experiences.
- Adding chemicals beyond sodium hydroxid is not recommended.
- The latest technology within water treatment and degassing is described with illustrations.
- A greater focus on the importance of degassing make-up water.

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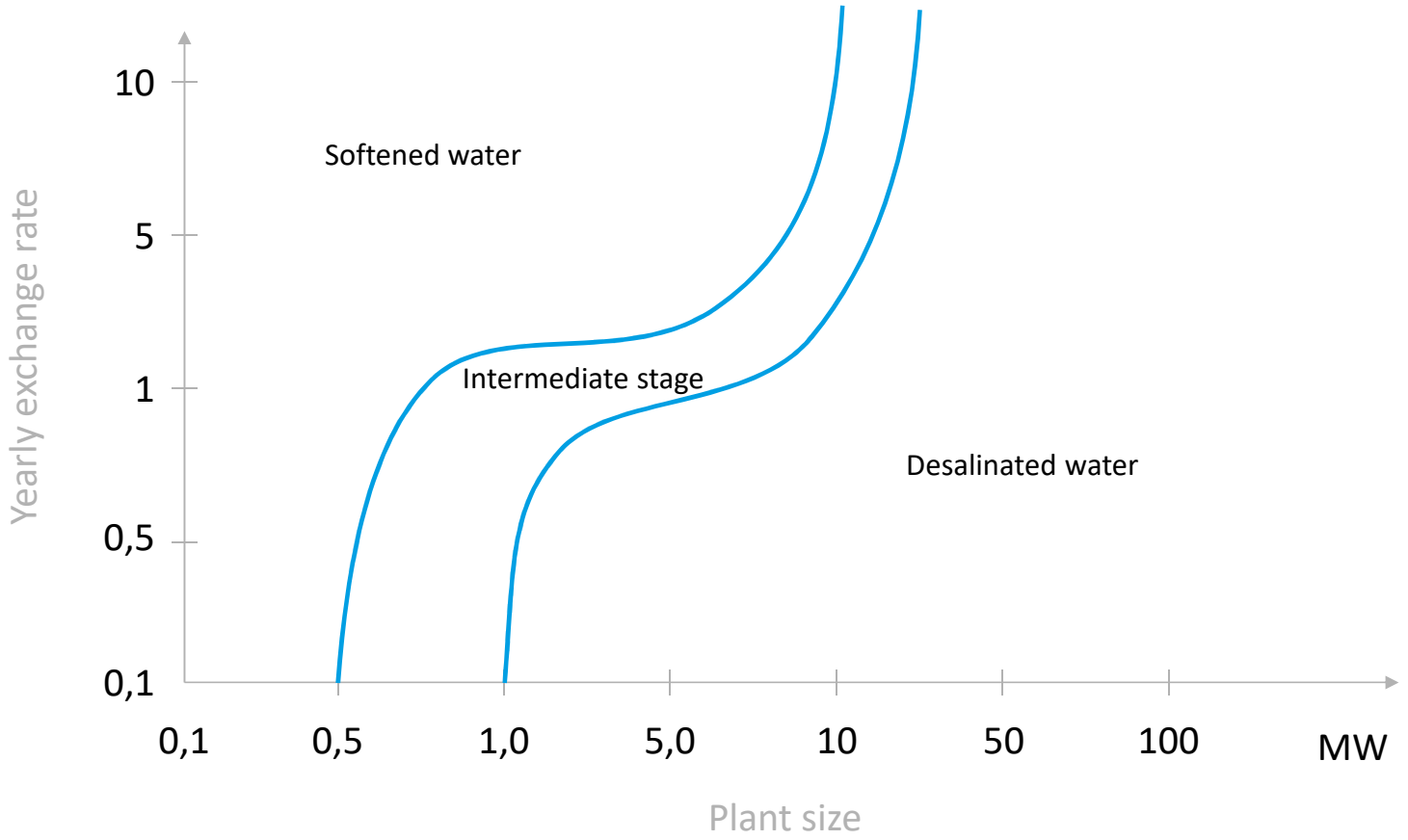

Indication for choise of water treatment system

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Quality of feed water		Drinking water	Softened	Deminieralized
Appearance		Clear and transperant		
Smell		Odorless		
Particle content	mg/l	< 10	< 5	< 1
Oil and grease content	mg/l	Oil and free of fat		
Leakage	°dH		< 0,1	< 0,01
Conductivity at 25 °C	µS/cm			< 10
Chloride, Cl^-	mg/l	< 300	< 300	< 0,5
Sulphate, SO_4^{2-}	mg/l			< 0,2
Total iron, Fe_{total}	mg/l	< 0,2	< 0,05	< 0,005
Total cobber, Cu total	mg/l	< 0,1	< 0,05	< 0,01

Specifications for make-up water

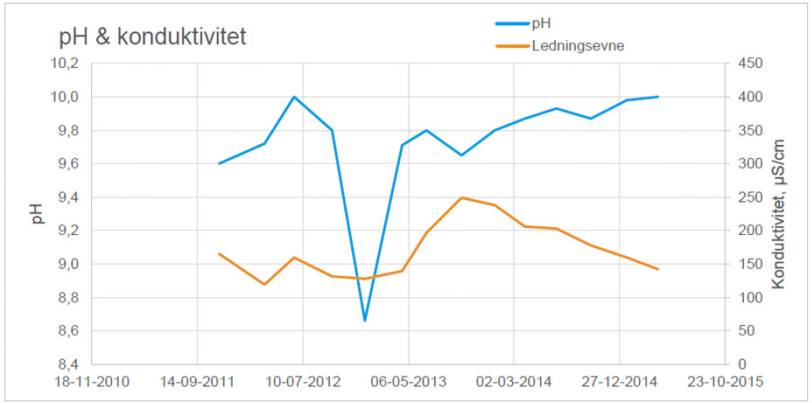
Source: Danish District Heating Association – ”Water Treatment & Prevention of Corrosion”.

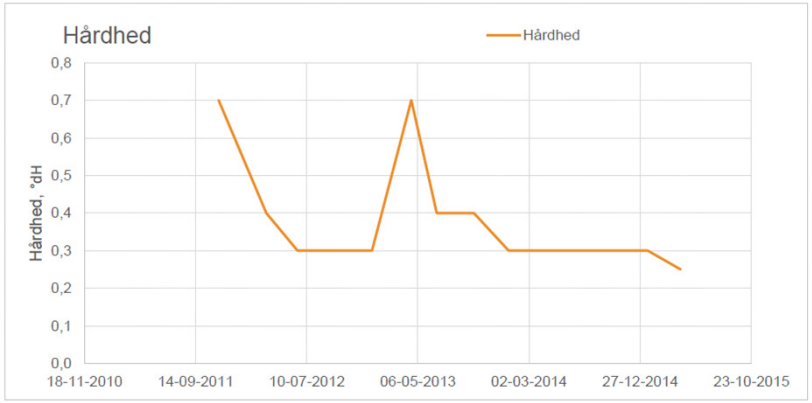
Download from: www.eurowater.com

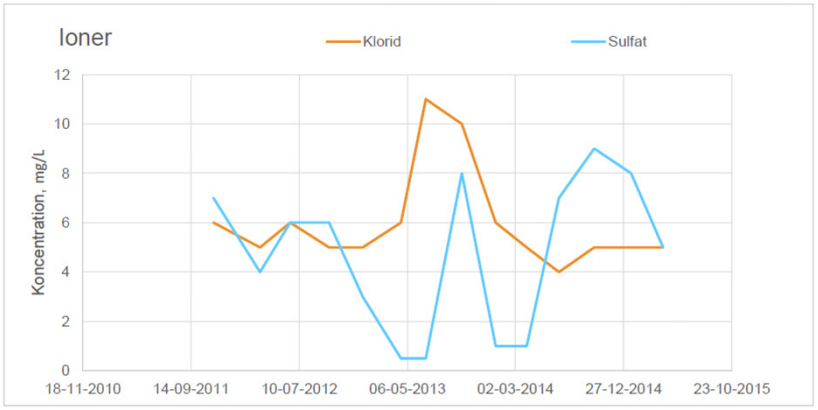
Quality		Untreated water	Softened	Partly demineralized	Demineralized
The quality of the added water.		Drinking water	Softened water	Softened and/or demineralized water	Demineralized water
Appearance	-	Clear	Clear	Clear	Clear
Smell	-	Odorless	Odorless	Odorless	Odorless
Particle content	mg/L	< 10	<10	< 5	< 1
Oil og grease content	mg/L	< 1	<1	< 1	< 1
pH value at 25°C			9,8 ±0,2	9,8 ±0,2	9,8 ±0,2
Leakage	°dH		< 0,5*	< 0,6* (was < 0,2 in 1999 recommandation)	< 0,6* (was < 0,1 in 1999 recommandation)
Conductivity at 25°C	µS/cm		< 1500	< 500	< 50** (was < 25 in 1999 recommandation)
Oxygen	mg/l		< 0,02	< 0,02	< 0,02
Chloride, Cl^-	mg/l	< 300***	< 300***	< 50***	< 3
Sulphate, SO_4^{2-}	mg/l				< 2
Nitrate, $NH_{3\ total}$	mg/l		< 10	< 5	< 5
Total iron, $Fe_{\ total}$	mg/l		< 0,1	< 0,2	< 0,05
Total cobber, $Cu_{\ total}$	mg/l		< 0,02	< 0,02	< 0,01

Water quality in the units (circulating water)

Kilde: Dansk Fjernvarme Vejledning – Vandbehandling og korrosionsforebyggelse - September 2015







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Development of water quality over time e.g

- Decreasing pH value and increasing hardness indicates break in of raw water.
- Changes in condutivity without similar changes in pH value can be caused by break in of raw water.

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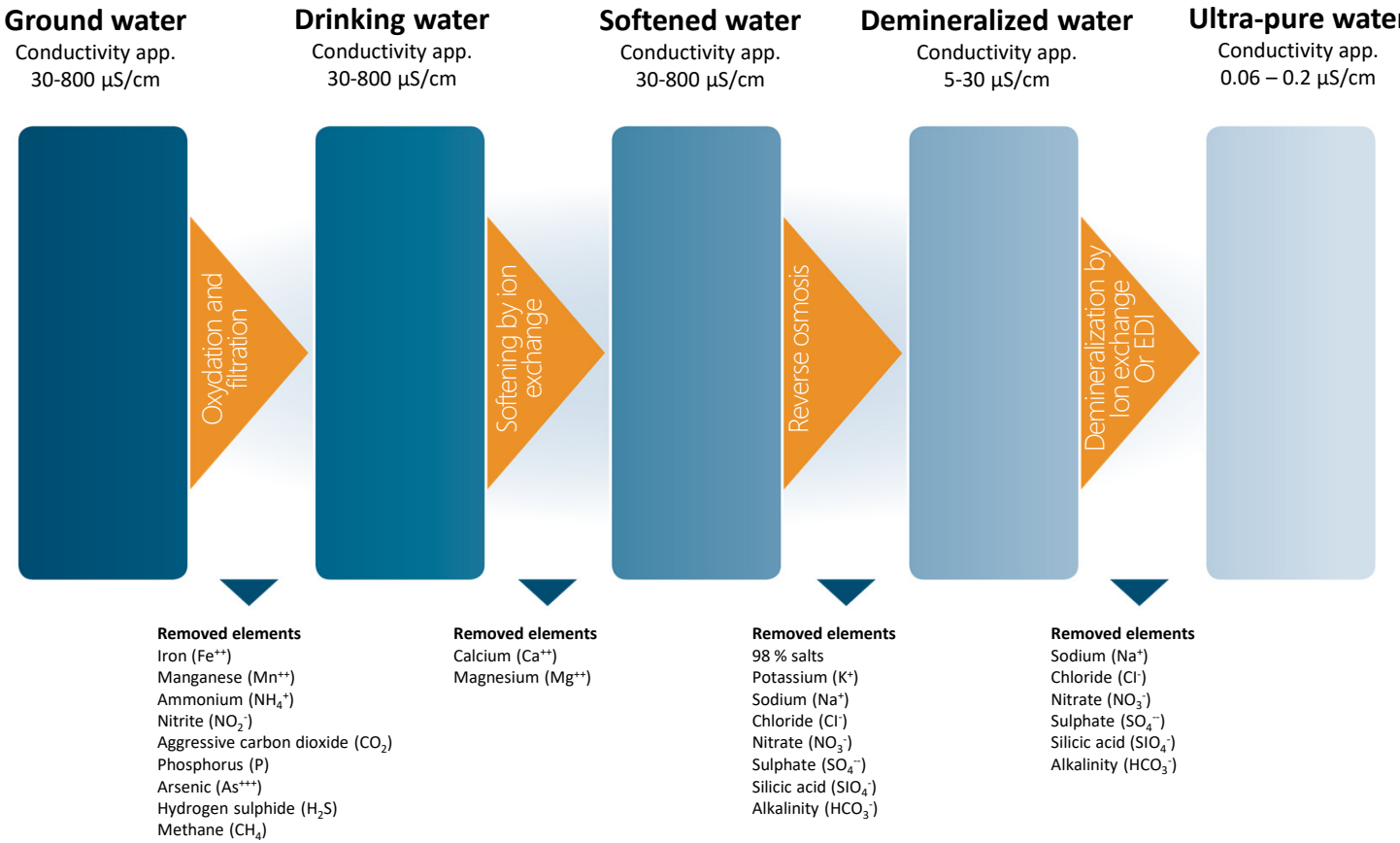

Filtration of water

From ground water to pure water

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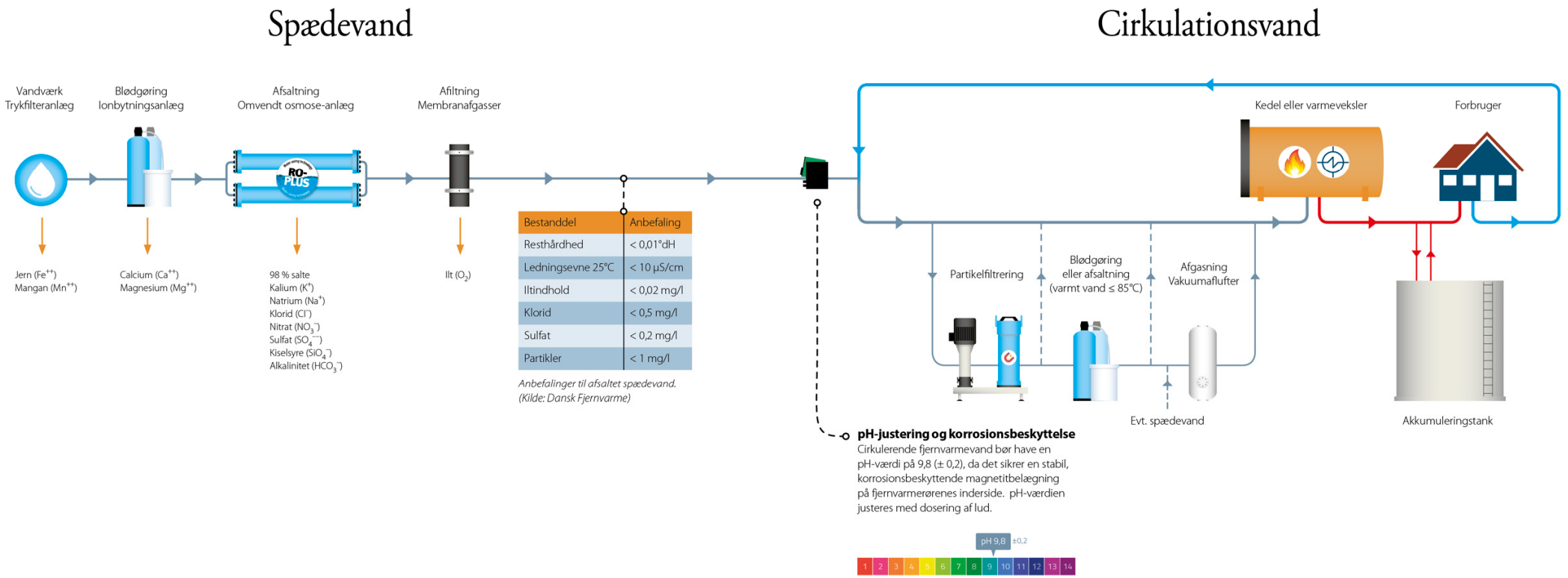

Make up and circulation water

Source: SILHORKO District Heating leaflet - 2017

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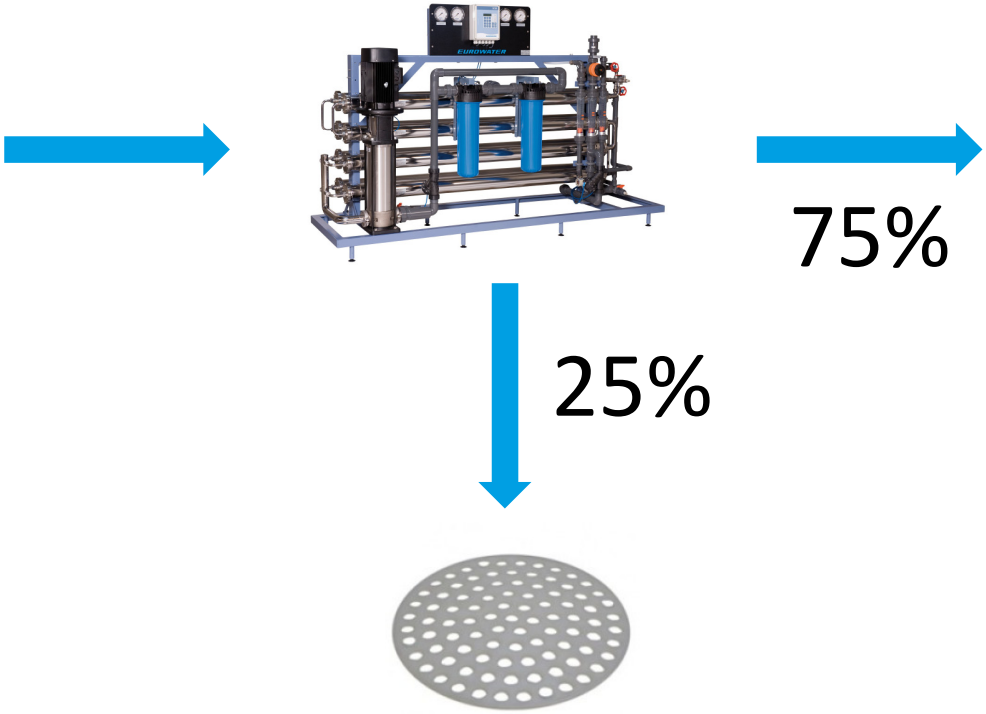
Membrane unit – 75-80% recovery



Water efficient solutions

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Membrane units – 85-90% recovery

Water saving technology RO-PLUS Water saving technology

Reduction in waste water = 40-60%

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RO units with high use of water "RO-plus"

Max pressure: 21 bar

Recovery: 85-90%

- As complete unit
- As upgrade for existing unit
- As capacity expansion
- Lower operation costs

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Treatment of permeate from RO units

Features of RO-plants

- Retains 95 – 99 % of water salts
- Retains <90 % the waters organic material
- CO_2 og O_2 is not retained!

Further treatment needed

- Degassing
- Dosage with lye (NaOH)

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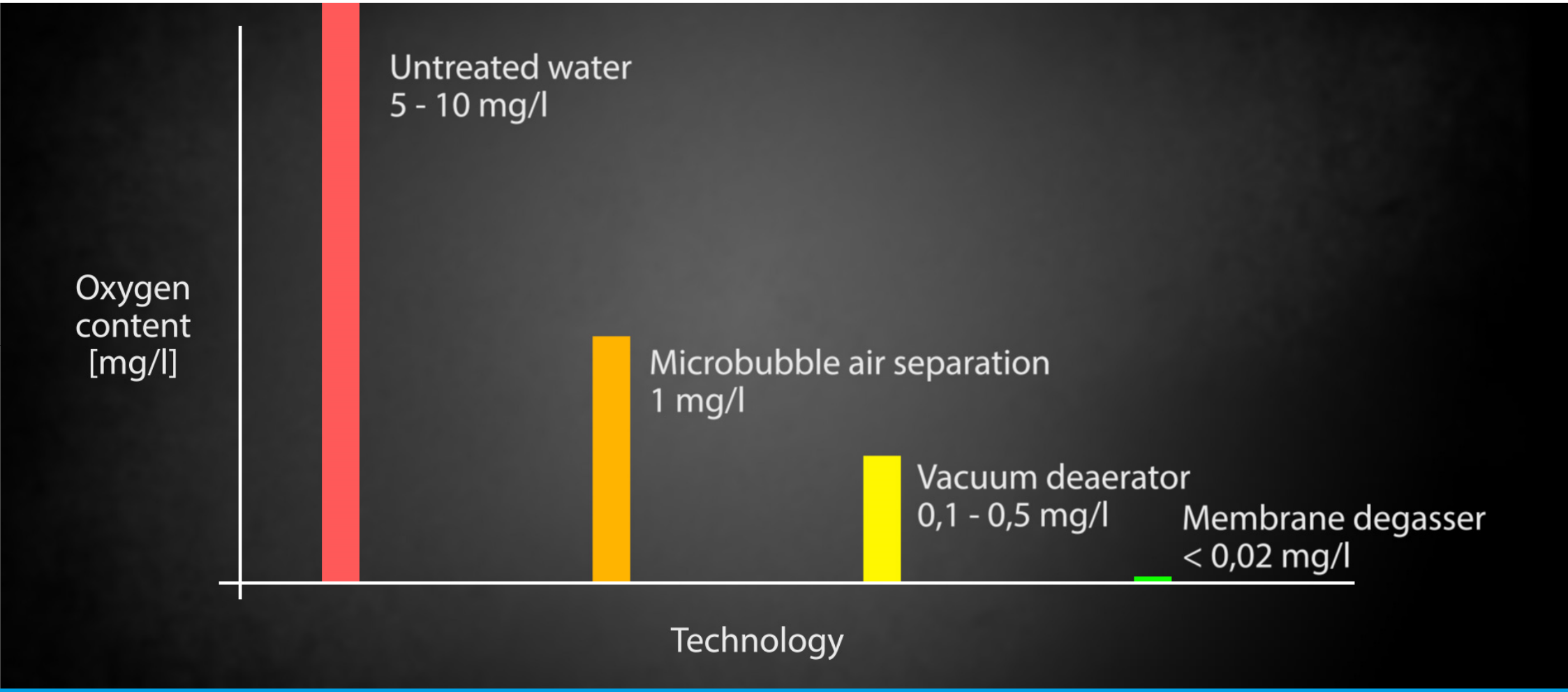
Degassing



Solution: Remove the Oxygen (Membrane degasser)

At low partial pressure we can remove a gas / oxygen from water – using a membrane degasser.


GRUNDFOS
3M
UltiCel


SILHORKO
24VDC
SILHORKO
SILHORKO
EUROWATER
NaCl level > H_2O level
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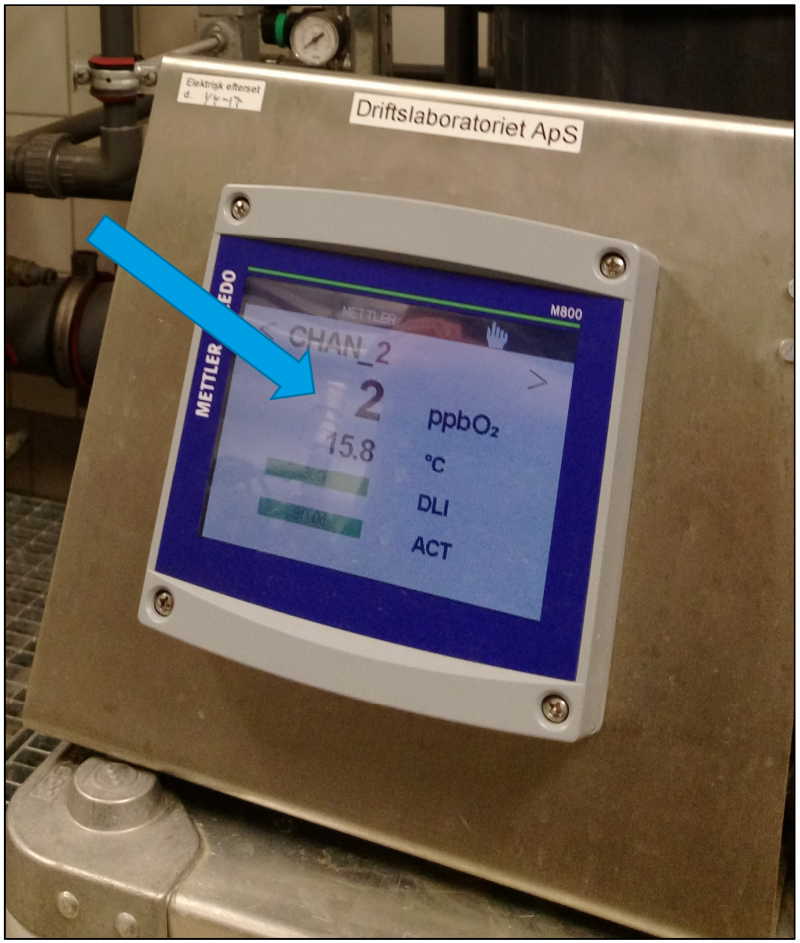
Results

Measuring oxygen level in districht heating make-up water

- Test of MDU-plant
- Test by independant laboratory
- Result: 2 – 5 ppb O_2



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Filtration of particles

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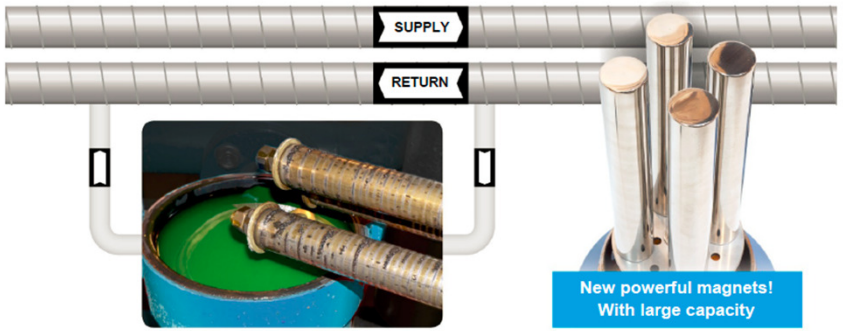
Bag filtration unit

For partial side stream filtration.

Particles from drinking water and corrosion products, sand and organic material can cause serious blockages of heat exchangers, erode components and cause corrosion in the district heating system.



- Salt and oxygen in district heating water acts as a catalyst for corrosion
- The salts contributes to the waters conductivity (electrochemical corrosion)
- The salt load in district heating water provides fertile ground for bacteria growth and hereby a microbial corrosion.
- The saltload is in crucial importance to how much NaOH to be used to raise the pH-value to 9,8.
- Demineralized water makes it easier to detect raw water mix-up.

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Summary: Salts

Advantages by optimally treated district heating feed water.

The use of correctly treated make up water will eventually become an advantage both regarding enviroment, maintanance and lifetime of a districts heating system.

- Oxygen is a condition for corrosion in pipe systems.
- No chemistry reacts quicker with oxygen than a steel surface in district heating systems.
- Remove the oxygen from the make up water before it is put into the district heating network.
- Possible need for oxygen scavenger is reduced enormously when degassed water is fed into the system and can in some cases be completely omitted according to Danish District Heating.
- Danish District Heating does not recommend oxygen scavengers, because they are increasing the salt load for the district heating system.

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Summary: Oxygen

Advantages by optimally treated district heating feed water.

The use of correctly treated make up water will eventually become an advantage both regarding enviroment, maintanance and lifetime of a districts heating system.

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Recommendations

- Make up water treatment:
  - Removal of hardness
  - Removal of corrosive salts
  - Removal of non-condensing gases (O_2, CO_2, N_2)
  - Adjustment of pH value.

- Typical water treatment solutions:
  - Softening Plant
  - Reverse Osmosis Plant (RO Plant)
  - MDU plant (Membrane Degasser Unit)
  - Dosing of NaOH.

Thank you for listening

Learn more on www.eurowater.com